International Journal of Electronics,
Communication & Instrumentation Engineering
Research and Development (IJECIERD)
ISSN(P): 2249-684X; ISSN(E): 2249-7951
Vol. 4, Issue 2, Apr 2014, 163-170

DESIGN OF DATA ACQUISITION SYSTEM FOR REAL TIME PARAMETER ANALYSIS IN INDUSTRIAL PROCESS PLANTS

P. A. SHINDE[1], K. V. JOSHI[2] & S. C. RAJGADE[3]

[1,2]Student of BE, Department of Instrumentation Engineering. AISSMS IOIT, Pune, Maharashtra, India

[3]Assistant Professer, Department of Instrumentation Engineering, AISSMS IOIT, Pune, Maharashtra, India

ABSTRACT

This paper describes a microcontroller-based data logging system to record temperature, pressure, level and flow for data acquisition applications. The system is simple to use, requires no additional hardware and allows the selection of amount of data and the time intervals between them. The collected data can easily be exported to a PC computer via a serial port. DAQ (Data Acquisition) is simply the process of bringing a real-world signal, such as a current, into the computer, for processing, analysis, storage or other data manipulation. A Physical phenomena represents the real-world signal you are trying to measure. In order to optimize the characteristics of a system in terms of performance, handling capacity and cost, the relevant subsystem can be combined together. Analog data is generally acquired and transformed into the digital form for the purpose of processing, transmission and display. Rapid advances in Personal Computer (PC) hardware and software technologies have resulted in easy and efficient adoption of PCs in various precise measurement and complex control applications. A PC based measurement or control application requires conversion of real world analog signal into digital format and transfer of digitized data into the PC. A data acquisition system that performs conversion of analog signal to digital data and the digital data to analog signal is interfaced to a PC to implement the functions of a measurement and control instrumentation applications.

KEYWORDS: Data Acquisition, Microcontroller, Communication

INTRODUCTION

Data logger plus graphical interface is called the Data Acquisition System (DAS).Early, expensive mainframe computers were used extensively for gathering multiple channels of data, primarily in large industrial or scientific applications. They were seldom used in small projects because of their relatively high cost. But the introduction of small rack mounted minicomputers that developed in the 1960s and later desktop personal-type computers that housed microprocessors and proliferated in the 1970s justified their use for smaller projects. Soon, data acquisition plug-in cards (as well as hundreds of other types of plug-in cards) for these small computers were a common means to collect and record data of all types. The processes to collect, analyze and store the data for later use is called logging. It is a process to record events during a test or measurement with the use of a system or a product.

The human brain and its memory, the natures creation, no doubt is best data logging mechanism. Where there is the need to collect information faster than a human, data logger can possibly collect the information and in case where accuracy is essential. A data logger is a device that can be used to store and retrieve the data. Data logging also implies the control of how sensor collects and analyzes the data. A data logger is used to collect readings, or output, from sensors. These sensors could be measuring industrial parameters such as pressure, flow and temperature or environmental

parameters such as water level, wind speed or solar radiation. Today there are sensors available which can measure virtually any physical parameter. The use of data loggers for environmental monitoring became common during the 1980's; coinciding with the explosion in personal computers (PC's). This is no coincidence since a data logger consists of many of the same, or similar, components used to manufacture a PC. Interfacing the data logger to the personal computer by using the serial (RS-232), minimization of power consumption in order to enhance battery life and preparing the user friendly graphical user interface (GUI) in visual language to operate the data logger. Real time assessment of indoor air and environment parameters has got tremendous energy saving potential.

To focus on this problem we are trying to develop multi-channel data acquisition system for temperature, level, pressure, and flow. We are introducing a new software name as FALCON. This is a type of process software, used for logging and gives the visual representation of real time process parameters. It also contains different and amazing features like alarm management, report generation, graphs etc which makes the acquisition system simple and user-friendly.

Design Consideration

All PC-based data acquisition systems will record extremely accurate, repeatable, reliable, and error-free data provided they are connected and operated according to the manufacturers recommended practices. These practices include selecting the correct sensors for the application, the proper wire and shielded cable; capturing the signals in proper magnitude, range, and frequency. Process parameters measurements are taken during several hours but the time between data point is variable; it takes from seconds to minutes. In addition, temperature, pressure, level and flow transmitters are placed far from the control and monitor room; therefore, the system design should meet the following requirements:

- It should be easily programmable. The user must be able to choose measurement rates from 1 s to 99 min.
- It should backup data when system power is momentarily disrupted, or removed entirely.
- It should have remote sensing devices for process parameters measurement.
- It should be able to export data to a PC computer via a serial port.
- It should be simple and inexpensive.

System Architecture

The main components of the system are as follows

- **Input/ Output Channels**

The output from a sensor or transmitter is connected to a data logger channel. A channel consists of circuitry designed to 'channel' a sensor signal (typically a voltage or current) from the sensor to the data logger processor. A single data logger can have a variety of channel types and from one to many channels (multi-channel data logger) - one channel is required for every sensor signal output. For example, four sensors can be connected to a four channel data logger and eight sensors to a eight channel logger. A multichannel logger will have from four to 16 channels. The I/O ports provide a means of sending data to, and receiving data from, devices such as the video adaptor, the disk subsystem, or analogue-to-digital transformers (ADCs) on plug-in data-acquisition cards. Software can use the assembly language IN or OUT instructions or their high level language counterparts, to communicate with hardware devices via the I/O ports. The output port is mainly connected to the PC via RS232 communication protocol.

Analog to Digital Converter (IC7109A)

In physical world parameters such as temperature, pressure, level and pressure are analog signals. A physical quantity is converted into electrical signals. We need an analog to digital converter to translate the analog signals to digital numbers so that the microcontroller can read them. Thus, an analog-to digital converter (ADC) is an electronic circuit that converts continuous signals to discrete digital numbers. Analog to digital converters are the most widely used devices for data acquisition. A digitizer converts one or more channels of analog signal to a sequence of corresponding digital values. The heart of a digitizer is an A/D converter, a device that samples an analog signal and converts the sample to a digital value. The TC7109A is a 12-bit plus sign, CMOS low power Analog to Digital Converter (ADC).

Only eight passive components and a crystal are required to form a complete dual slope integrating ADC. The TC7109A provides a versatile digital interface. In the Direct mode, Chip Select and HIGH/LOW byte enable control parallel bus interface. In the Handshake mode, the TC7109A will operate with industry standard UARTs in controlling serial data transmission ideal for remote data logging. Control and monitoring of conversion timing is provided by the RUN/HOLD input and Status output.

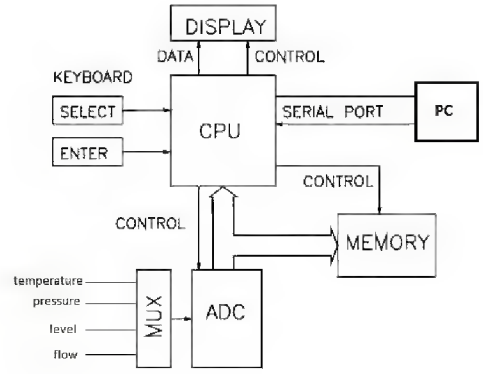

Figure 1: Block Diagram of System

- **Multiplexer (IC CD4051)**

These analog multiplexers are digitally controlled analog switches having low ON impedance and very low OFF leakage currents. Control of analog signals up to 15Vp- p can be achieved by digital signal amplitudes of 3 to 15V. The multiplexer circuits dissipate extremely low quiescent power over the full VDD-VSS and VDD-VEE supply voltage ranges, independent of the logic state of the control signals. When a logical 1 is present at the inhibit input terminal all channels are OFF. CD4051 is a single 8-channel multiplexer having three binary control inputs. A, B, and C and an inhibit input. The three binary signals select 1 of 8 channels to be turned ON and connect the input to the output.

- **Microcontroller (AT89C55WD)**

The first and foremost criterion for choosing a microcontroller is that it must meet the task at hand efficiently and cost effectively. In analyzing the needs of a microcontroller based project, it is seen whether an 8-bit, 16-bit or 32-bit microcontroller can best handle the computing needs of the task most effectively. The AT89C55WD is a low-power, high-performance CMOS 8-bit microcontroller with 20K bytes of Flash programmable read only memory and 256 bytes of RAM. The device is manufactured using At meals high-density nonvolatile memory technology and is compatible with the industry standard 80C51 and 80C52 instruction set and pin out.

The on-chip Flash allows the program memory to be user programmed by a conventional nonvolatile memory programmer. By combining a versatile 8-bit CPU with Flash on a monolithic chip, the Atmel AT89C55WD is a powerful microcomputer which provides a highly flexible and cost effective solution to many embedded control applications. The AT89C55WD provides the following standard features: 20K bytes of Flash, 256 bytes of RAM, 32 I/O lines, three 16-bit timer/counters, a six-vector, two-level interrupt architecture, a full-duplex serial port, on-chip oscillator, and clock circuitry. In addition, the AT89C55WD is designed with static logic for operation down to zero frequency and supports two software selectable power saving modes. The Idle Mode stops the CPU while allowing the RAM, timer/counters, serial port, and interrupt system to continue functioning. The Power-down Mode saves the RAM contents but freezes the oscillator, disabling all other chip functions until the next external interrupt or hardware reset.

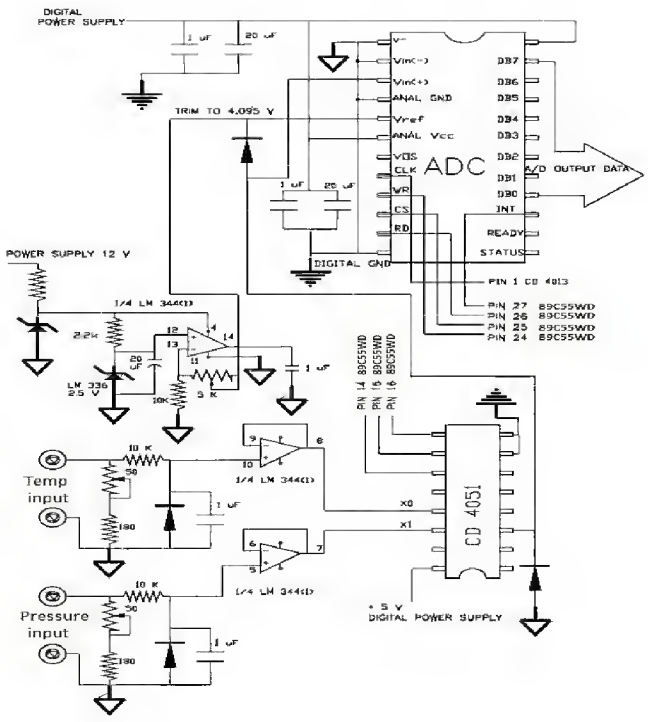

Figure 2: MUX CD4051 Interfacing to ADC for Two Inputs

- **Communication Protocol (RS232)**

As this was before the days of TTL logic, it should not be surprising that the standard does not use 5 volt and ground logic levels. Instead, a high level for the driver output is defined as being +5 to +15 volts and a low level for the driver output is defined as being between 5 and 15 volts. The receiver logic levels were defined to provide a 2 volt noise margin. As such, a high level for the receiver is defined as +3 to +15 volts and a low level is 3 to 15 volts. The RS 232 standard also limits the maximum slew rate at the driver output. This limitation was included to help reduce the likelihood of crosstalk between adjacent signals.

The slower the rise and fall time, the smaller the chance of cross talk. With this in mind, the maximum slew rate allowed is 30 V/ms. additionally; a maximum data rate of 20k bits/second has been defined by the standard. Again with the purpose of reducing the chance of cross talk. Due to its relative simplicity and low hardware overhead (as compared to parallel interfacing), serial communications is used extensively within the electronics industry. Today, the most popular serial communications standard in use is certainly the EIA/TIA232E specification.

This standard, which has been developed by the Electronic Industry Association and the Telecommunications Industry Association (EIA/TIA), is more popularly referred to simply as RS232 where RS stands for recommended standard. In recent years, this suffix has been replaced with EIA/TIA to help identify the source of the standard.

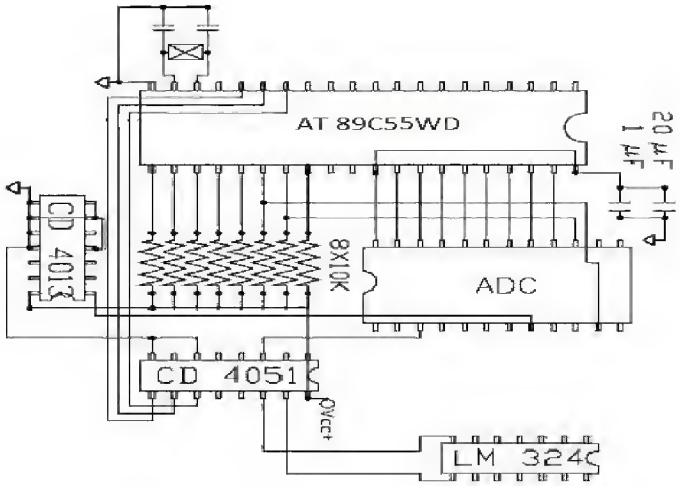

Figure 3: Input Scanner (Interfacing to Microcontroller)

Data Acquisition Software (Falcon)

Process parameter values are important from the process performance analysis point of view. This is the main purpose of Data Acquisition System. With the popularity of personal computers, Pc based data acquisition has got vital importance in process industries. Falcon is the data acquisition software intended for the purpose of storing data and gives user some additional facilities regarding presentation of data. It is basically paper-less recorder. Scanners, flow indicator and totaliser, Digital inputs are different inputs those communicate through RS232 serial port and stores data values and present them on different screens. Reports and Alarm summary have export to Excel Facility.

- **Features**
  - Auto Report generation in Excel format at predefined intervals.
  - Auto Reports can be send through e-mail to predefined address.
  - This software is made on Windows platform, which is familiar to most of the users.
  - Real Time and historical trend available in graphical format.
  - Triggers can be added on Tags.
  - Audible and visible indication of alarms.
- **Process Diagram**

Presentation of instantaneous values of process parameter User selected Mimic Diagram is displayed in this section. These include Chillers, Boiler and, Reactors etc as per the users process. Here parameters values are displayed.

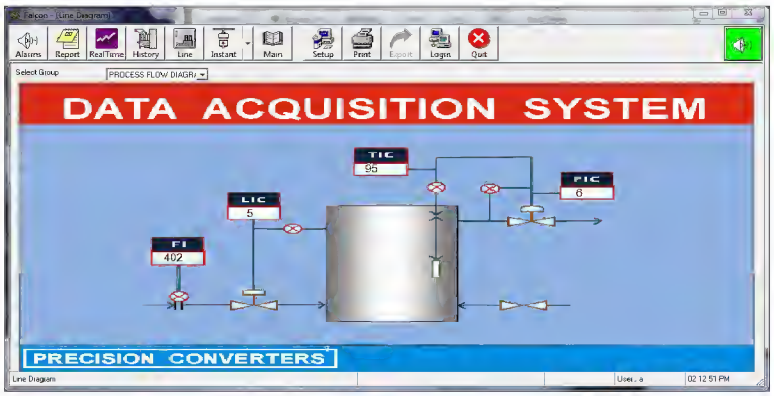

Figure 4

- **Trend**

Real Time screen is a graphical representation of Instantaneous process data. Different parameters are displayed in different color. Values are displayed. Normal operating range of the process value is shown by different color bands. Trending is the industrial way of viewing or professionally viewing the data. trending is the easy way to monitor the real time parameter.

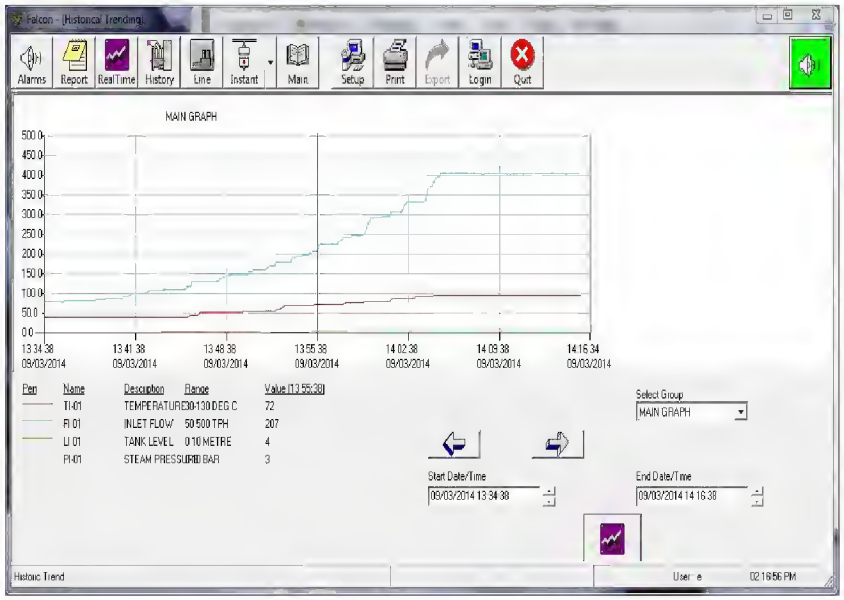

Figure 5

- **Report Generation**

Reports are stored data of the entire process variable. As interval is user defined so you can view data of, as minimum of 1sec. between two readings is possible. You select the interval such that it covers your batch. Here also exporting of data to Excel facility is available just by clicking the Export button. Auto report is also a special facility of this software. Timing of auto is defined in Set up. Send auto report by E-mails. Heading of report is editable area. User has the option to change the default heading. Otherwise default heading will be taken as heading.

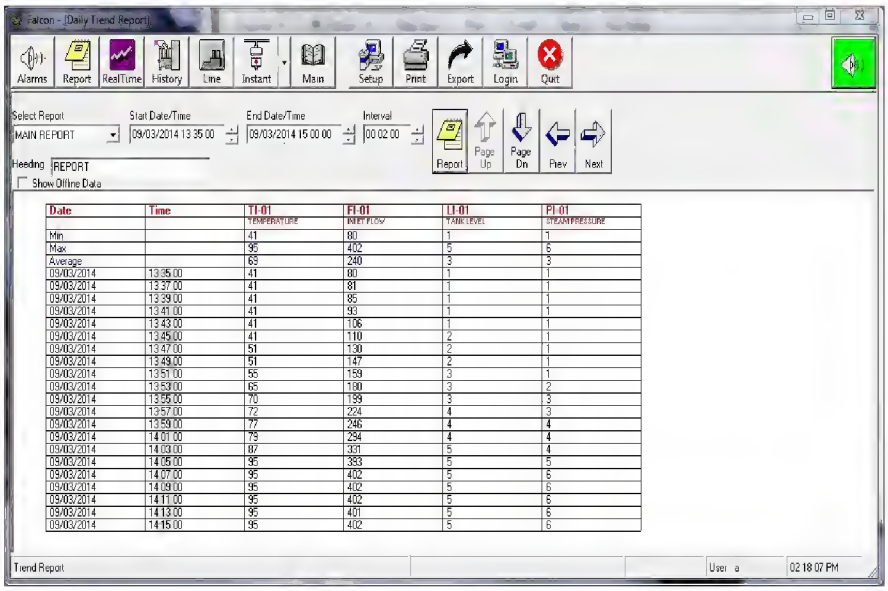

Figure 6

CONCLUSIONS

A microcontroller-based data acquisition system has been described. It appears to be both an effective tool in intensive routine measurements and for research. It is now successfully applied for logging and monitoring of data in various industries. also it gives a better visualization of process diagram and parameters. Falcon is very simple logging software which can be easily editable. it gives various facilities and makes acquisition easy.

RESULTS

The values in table shows that real time parameters at different time has been logged in the hard disk of PC in the excel sheet format. Values automatically logged as per user variable time interval.

Table 1

Date	Time	Temp (deg c)	Flow (TPH)	Level (metre)	Pressure (bar)
09/03/14	13.51	55	159	3	1
09/03/14	13.53	65	180	3	2
09/03/14	13.55	70	190	3	3
09/03/14	13.57	72	224	4	3
09/03/14	13.59	77	246	4	4
09/03/14	13.61	79	294	4	4
09/03/14	13.63	87	334	5	2

ACKNOWLEDGEMENTS

We have great pleasure in presenting our paper title, "Design and analysis of Data Acquisition system for Industrial process plants" We would like to express our sincere and whole hearted thanks to our guide Prof. S. C. Rajgade, our project coordinator Dr. A. D. Rahulkar and HOD Prof. H. P. Chaudhari. We are extremely obliged for his guidance received time to time during this project. Mr. Pote and Mr. Khole who distributed with us his valuable time and knowledge and provided the guidance throughout the project work.

REFERENCES

1. Andrew J. Thompson, John L. Bahr and Neil R. Thompson, "Low Power data logger", preceeding of conference depatrment of physics, university of otago.
2. Muhammad Ali Mazidi and Janice Gillispe Mazidi, "The 8051 microcontroller and embedded systems" pearson education Ltd, India, 2004.
3. Peter Roberson, "Using Data Loggers", science teachers workshop, North sydney, 2004.
4. H.S.Kalsi, "Electronic Instrumentation", Tata MacGrew-Hill Ltd,*New* delhi, 1999.
5. Bela G. Liptak, "Process Control-Handbook",Radnor,Pennsylvania 1995.
6. Negro V. C., "A Battery Operated Bubble Memory Data-acquisition System", IEEE Transactions on, Instrumentation and Measurement 37, (2), 305-308, (1988).